Ann. Natal Mus. Vol. 16 Pages 191—208 Pietermaritzburg June, 1964

A new family of Acarines belonging to the Suborder Sarcoptiformes parasitic in the hair follicles of Primates*

by

M. M. J. Lavoipierre

(George Williams Hooper Foundation,
University of California Medical Centre, San Francisco)

INTRODUCTION

A recent survey of ectoparasites of primates received from South America by the Primate Research Foundation of Burlingame, California, has brought to light two new species of a remarkable new family of sarcoptiform mites which inhabit the sinus-hair follicles of a squirrel monkey, *Saimiri sciurea.* The mites were found after pieces of the lip of a male monkey which had died at Burlingame had been dissolved in potassium hydroxide. Following the discovery of the parasites, an extensive series of histological sections was prepared from the lips of animals originally obtained from the Primate Research Foundation and maintained in captivity for several months at the Hooper Foundation. A study of this material enabled the exact relationship of the mites to the hair follicle to be determined and provided evidence that infestation with the acarines may give rise to the destruction of the follicle as a result of secondary infection.

In this paper a description is given of the two new species of mites discovered in the follicles. A new genus and a new family of the suborder Sarcoptiformes are proposed for the new species, the descriptions of which are based only on the female sex since no males were found despite a diligent search of a dozen monkeys. The localization of the mites in the skin is briefly described; a longer report describing the host-parasite relationship and the occurrence of follicular and perifollicular changes following infestation of the follicles will be published elsewhere.

I wish to place on record my most grateful thanks to my friend and colleague, Dr Frederick Dunn of the Hooper Foundation, for his admirable co-operation in this project and to Frank Lambrecht and Rosalie Du Plessis, who assisted with the collection of the material. To Dr William E. Greer, Director of the Primate Research

---

* This investigation was supported by Public Health Research Grant AI 04189-02 from the ICMRT Program, Office of International Research, National Institutes of Health, United States Public Health Service.

Centre of Burlingame, I am greatly indebted for having presented me with many interesting primates for study, including a proportion of the animals from which the mites described in this paper were obtained. To Paul Budwiser, my laboratory technician, I owe very special thanks for the excellent sections he provided me with and for the many long hours of his own time that he devoted to producing hundreds of slides for examination. To Dr James Douglas, Professor of Parasitology at the University of California School of Veterinary Medicine at Davis, where this work was carried out, I extend my most gracious thanks for his generous provision of facilities and his many kind favours. To Dr Ralph Audy, Director of the Hooper Foundation and Professor of Tropical Medicine at the San Francisco Medical School of the University of California, I owe a very special debt for his unfailing support of this research project. Finally, I am grateful to Dr R. F. Lawrence who has allowed me to examine paratype material of *Rhynchoptes recurvidens*.

It gives me special pleasure to dedicate this paper to my friend of many years standing and erstwhile teacher, Dr R. F. Lawrence. His infectious enthusiasm, his patience and understanding, and his profound knowledge of and love for nature did more than any other influence to inspire me to follow a career in biology. My indebtedness to Frederick Lawrence is indeed very great.

REVIEW OF THE LITERATURE

Within recent years several excellent general accounts of parasites of primates have been published, notably by Mendheim (1958), Ruch (1959), and Graham (1960). The most extensive of these reviews and one which has become a standard source of reference is that of Ruch, who gives a very thorough and useful summary of pulmonary disease caused by mesostigmatic mites and dermatoses resulting from infestation of the skin by *Sarcoptes* spp. Despite the excellence of Ruch's general treatment of the subject of ectoparasitism in primates, his survey is not comprehensive and certain species of acarines are omitted from his account. The most important omission is undoubtedly *Psorergates cercopitheci*, a parasitic trombidiform mite, recorded by Lavoipierre and Crewe (1955) and Zumpt & Till (1955) from *Cercopithecus mona mona* and *C.aethiops pygerythrus* respectively. The acarines were reported as being responsible for clinically apparent mange, but nothing is known of the microscopic changes which they produce in the skin of the monkeys. Although no histopathological studies have been carried out on infected animals, future research may show that *P.cercopitheci* is a parasite of the hair follicles since other species of *Psorergates* are known to live in this site in the skin of other hosts.

To Ruch's account of sarcoptiform mites infesting primates should be added the species of the family Psoralgidae described by Lavoipierre (1955) and Gaud and Till (1957) from cercopithecoids and simioids. This little known family, the subject of a recent study by da Fonseca (1954), is now known to include other undescribed forms from primates (Lavoipierre, in preparation). Equally interesting is the occurrence of listrophorid or fur mites on several species of lemurs (Lawrence, 1958). Until the publication of Lawrence's paper primates were not regarded as harbouring these interesting parasites. Our own survey of primate parasites has recently shown that fur mites have a much wider distribution on these animals than has hitherto been believed.

Of the several new families of sarcoptiform mites described within the last decade, the most interesting to the student of primates is the Lemurnyssidae which was proposed by Fain in 1957 to receive an unusual acarine, *Lemurnyssus galagoensis*, recovered from the nasal passages of *Galago senegalensis moholi*. To the family Lemurnyssidae also belongs *Mortelmansia longus* and *M. brevis*, both described by Fain in 1959 from specimens taken from the nasal passages of several *Saimiri sciurea*, which had died at the Antwerp Zoo shortly after their arrival from South America. Although lemurnyssids have thus far been collected only from lorisoids and pithecoids, caution should be exercised in suggesting that the mites may be useful phylogenetic labels (Fain, 1959a) until our knowledge of primate parasitology is considerably more extended than it is at the present time.

Finally it is of interest to note the description by Fain in 1959 of two remarkable demodicids, *Rhinodex baeri* and *Stomatodex galagoensis* taken from the nasal and buccal mucosa of *Galago senegalensis moholi*, the first new genera to be added to the family Demodicidae since Owen's description of *Demodex* in 1843. Although these mites are not sarcoptiforms and would seem to have no place in this review, nonetheless their discovery points to an important lesson, namely that no site should be overlooked by the parasitologist interested in acarine parasites of primates.

DESCRIPTION OF THE NEW FAMILY AUDYCOPTIDAE

Idiosoma elongated and unsegmented. Gnathosoma long, palp with two free segments and chelicerae with terminal chelae; last segment of palp with a few small recurved processes. A dorsal shield on the propodosoma; no other shields on the dorsal or ventral surface. Dorsal surface with two pairs of specialized sensory organs (modified setae) on the propodosoma and two pairs of conspicuous furcate setae on hysterosoma, all arising from pit-like depressions in the integument. Propodosoma with two pairs of sclerotized, transverse bars. Legs I and II well separated from legs III and IV. Legs I and II with ventro-lateral cupulate expansions on the first four segments, with sensory setae (solenidia and trichobothria), and tarsi terminating in a stalked pulvillus and a pair of small claws. Legs III and IV distinctly more sclerotized than legs I and II, with no specialized sensory setae. Tarsi III and IV terminating in a stout claw, no pulvillus, and with or without a very long, slender seta. Anus terminal, genital opening in ventral midline between coxa II and coxa III.

Audycoptes, N.GEN.

Idiosoma elongated, unsegmented, with only a small dorsal propodosomal shield. Integument transversely striated, particularly on the propodosoma, where the striations produce well-marked lateral indentations. Dorsal surface with two pairs of specialized sensory organs (modified setae) on the propodosoma and two pairs of conspicuous furcate setae on the hysterosoma; each with a closely appressed, anteriorly placed, shield-like structure at its base, and arising from a conspicuous cup-like depression with a sclerotized rim. Propodosomal sensory organs consisting of a large pair of thorn-like, or pad-like, structures and a much smaller pair of knob-like protuberances vesicular in appearance. Propodosoma with two pairs of heavily sclerotized, laterally placed, transverse bars, set on slightly thickened integument. Anterior pair short and clearly dorsal in position, lying just posterior to leg II. Posterior pair much longer, situated at level of propodosomal sensory organs; each bar encircling body from dorsal (short arm) to the ventral surface (long arm) and in some specimens appearing to be partially buried beneath integument laterally.

Legs I and II, extending forwards well separated from legs III and IV which are directed backwards. Leg I lying ventral to leg II, both six segmented; tarsus, tibia, genu, and femur of each leg with ventro-lateral cupulate expansions; tarsi with two small claws and a pulvillus on a long stalk. On the medial side of the 3rd segment of each leg, a scale-like trichobothrial seta terminating in a long flagellum. Tarsus and tibia of legs I and II with a conspicuous solenidion. Legs III and IV five segmented, noticeably more heavily sclerotized and stouter in appearance than legs I and II; trochanter distinctly more enlarged than other segments. Tarsi ending in a well developed claw; with or without a very long seta; pulvillus absent.

Gnathosoma elongated. Palp with two free segments, the apical much smaller than the penultimate segment; apical segment with some very small calcarations or tooth-like processes. Chelicera chelate at the tip. Anus terminal. Genital opening distinct and lying in midline ventrally between legs II and III.

Generic type: *Audycoptes greeri* n.sp.

Audycoptes greeri n.sp.

♀ Idiosoma shaped as a rhombus with the widest portion at the level of coxa IV. With transverse striations, difficult to discern on the hysterosoma, but conspicuous on the propodosoma, particularly the lateral edges, where the integument is deeply indented by grooves (only the propodosomal striations are indicated in figs. 1 and 2)

Dorsal surface—Propodosomal shield flask shaped with fine punctations. Lateral propodosomal sclerotized bars as in fig, 1. Close behind the medial tips of the first pair of propodosomal bars, a pair of long fine setae and more medially situated a pair of very minute setae. Outer pair of propodosomal sensory organs large and thorn-shaped, inner pair much smaller and vesicular in appearance (see fig. 3, C). Hysterosomal furcate setae conspicuous, anterior pair distinctly larger than posterior pair; each seta thorn-like with a long flagellum arising close to its base. The propodosomal sensory organs and the hysterosomal furcate setae all protected anteriorly at their bases by a small shield-like structure, which appears to be fused with the individual seta or organ. Each seta or organ arising from a pit-like depression in the integument; remarkably similar to trichobothria in morphology. The arrangement of other setae on the dorsal surface of the body as follows. At the level of coxa I, a pair of moderately long fine setae; lying between these a pair of very minute setae. Laterally at the level of coxa IV a pair of very small, fine setae. Opisthosoma with three pairs of long, conspicuous, lanceolate setae. First pair flanking closely the posterior pair of furcate setae; remaining two pairs distinctly shorter and stouter than the first pair, arising at the extremity of the opisthosoma (see fig. 1).

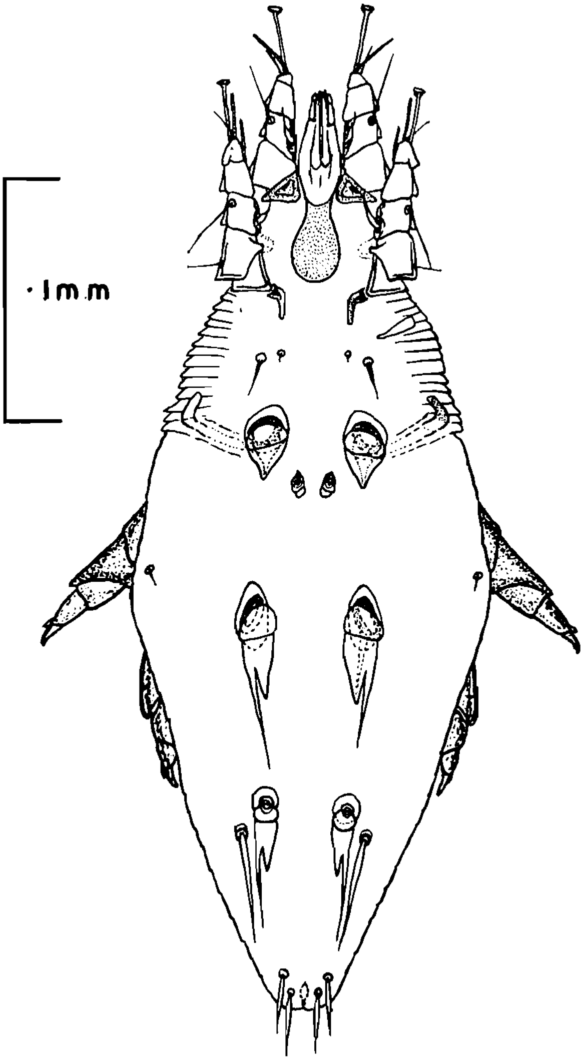

Fig. 1. *Audycoptes greeri* n. sp. ; dorsal view.

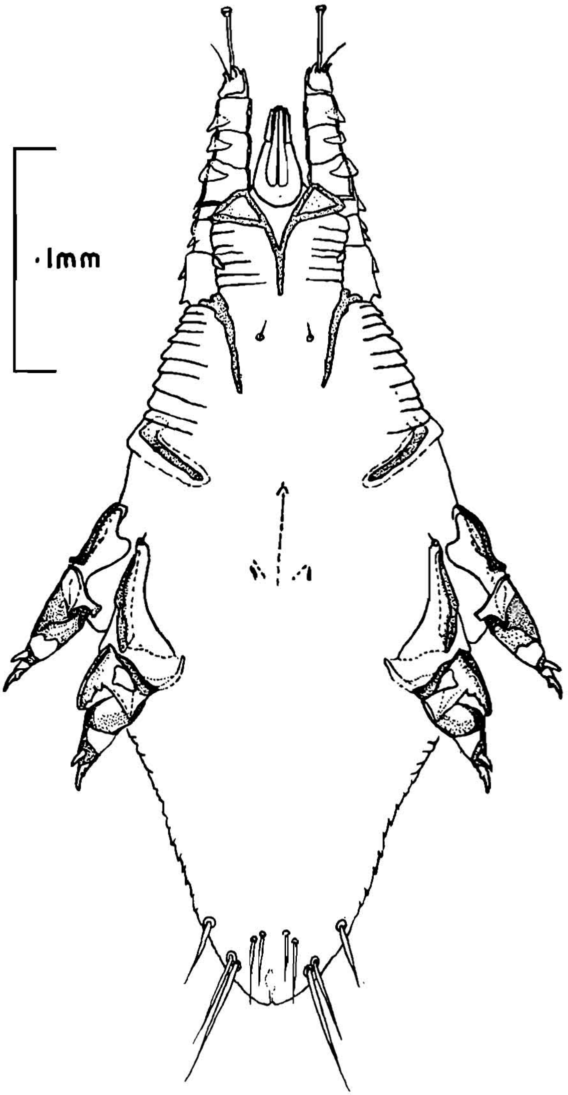

Fig. 2. *Audycoptes greeri* n. sp. ; ventral view.

Ventral surface.—With transverse striations, well marked on the propodosoma (in fig. 2 only the conspicuous striations shown). A pair of small, fine setae lying between epimera of leg II, a second pair of similar setae arising at the tips of coxa IV. Posteriorly opisthosoma provided with five pairs of lanceolate setae arranged as follows: medially two pairs of moderately long setae, laterally three pairs of longer setae, the first pair well separated from the two posterior pairs whose setal bases are partially fused together. Ventral arm of posterior propodosomal bars long and conspicuous on ventral surface. Anal opening terminal. Genital opening as in fig. 2.

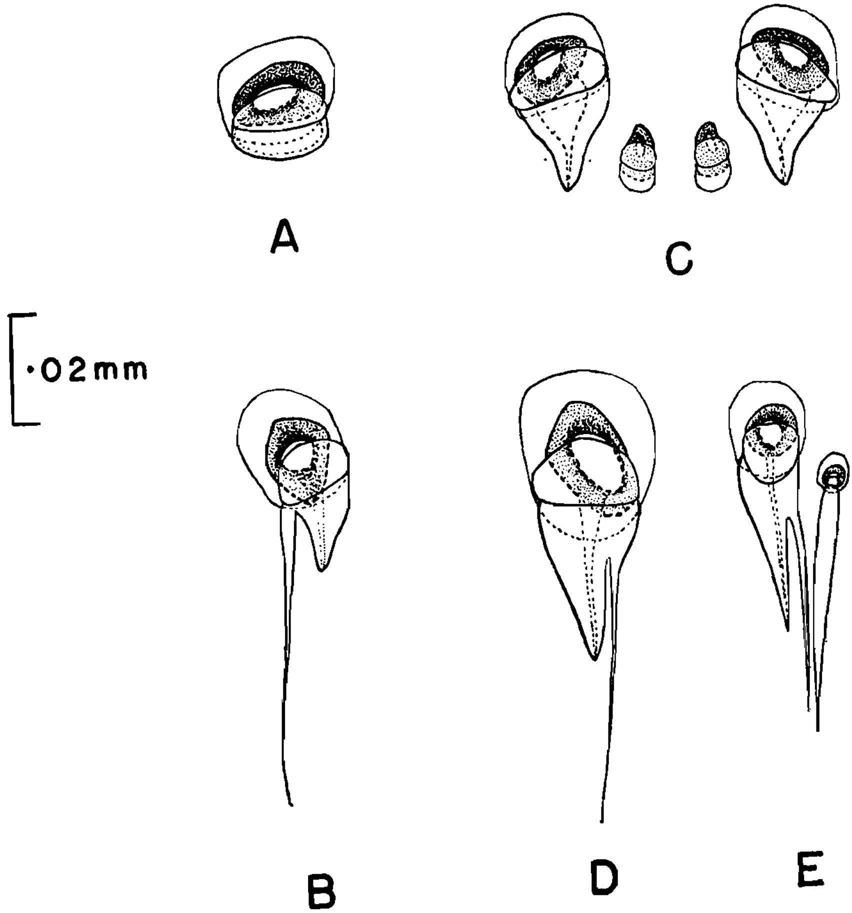

Fig. 3. Propodosomal sensory organs and hysterosomal furcate setae of *Audycoptes* spp. *A*, an outer propodosomal sensory organ of *A. lawrencei*; **B**, an anterior furcate seta of *A. lawrencei*; **C**, inner and outer propodosomal sensory organs of *A. greeri*; **D**, an anterior furcate seta of *A. greeri*; **E**, a posterior furcate seta and anterior opithosomal seta of *A. greeri*.

Legs.—Leg I lying ventral to leg II; both legs directed well forwards and lying very close to, and parallel to the gnathosoma. Viewed from the dorsal surface, leg II is clearly superimposed over leg I in specimens not crushed by the weight of the cover-slip. The normal position assumed by the legs when the mites are resting in the follicle is shown in text-fig. 2. In the figure of the dorsal surface of the mite (fig. 1) leg II has been displaced outwards in order to illustrate salient features of the first two pairs of limbs. Legs III and IV normally protrude from the sides of the body as shown in fig. 2.

Epimera of legs I united in a bar to form a sternum, the epimera of all the other legs free. Legs I and II strikingly different to legs III and IV. Legs I and II with ventro-lateral cupulate expansions on the tarsus, tibia, genu and femur (particularly noticeable on the 2nd, 3rd, and 4th segments) giving the legs the general appearance of being calcarate, an effect heightened by the angulated femur. Tarsus of each leg the shortest segment, bearing a pair of claws and a pulvillus on a long stalk; with a conspicuous solenidion and a moderately long, fine seta, the solenidion of tarsus I directed laterally. Tibia I and II with a dorso-medial solenidion directed forwards and overlying the tarsi. Genu of legs I and II with a conspicuous trichobothrium arising from a deep cup-like pit with sclerotized rim; trichobothrium scale-like, slightly concave, attenuated to form a long flagellum (see fig. 4, B). In addition, genu I and genu II bear a long, slender, dorso-lateral seta. Femur I and II with a similar but shorter seta laterally. Legs III and IV five segmented, very similar to each other in appearance, shorter, stouter, and distinctly more sclerotized than legs I and II. Coxae contiguous. Trochanter (4th segment) of both legs greatly enlarged, with a powerful ventral spine (see fig. 4, A); spine of trochanter IV more medially placed than that of trochanter III. Tibia III and IV with a large ventrolateral thorn, that of III slightly stouter than that of IV. Tarsi III and IV each bearing a small ventral tubercle and terminating in a very powerful and conspicuous claw.

Material examined.—A series of females, including a specimen containing a larva, mounted (after clearing in KOH) in Ewing's modification of Berlese's gum chloral mountant; the larva clearly shows the anlage of the sensory organs and furcate setae, and leg III closely resembles that of the adult in general appearance. The measurements of five adult specimens are as follows:

Length (in mm) (from the tip of gnathosoma to the end of the body)	Breadth (in mm) (at the widest part)
0·383	0·128
0·402	0·137
0·383	0·146
0·402	0·173
0·392	0·154

Holotype and paratypes in the acarological collection of the Department of Entomology and Parasitology at the University of California at Davis. Paratypes in the acarological collection of the George Williams Hooper Foundation, University of California Medical Centre, San Francisco.

All material was obtained from the squirrel monkey, *Saimiri sciurea.* The hosts had been collected in Eastern Peru shortly before they were examined in San Francisco for the presence of parasites. A few animals kept in captivity in California and examined many months after their arrival also proved to harbour the mites.

I have much pleasure in naming the genus after Dr J. R. Audy and the species, after Dr W. Greer, without whose assistance this project could not have been undertaken.

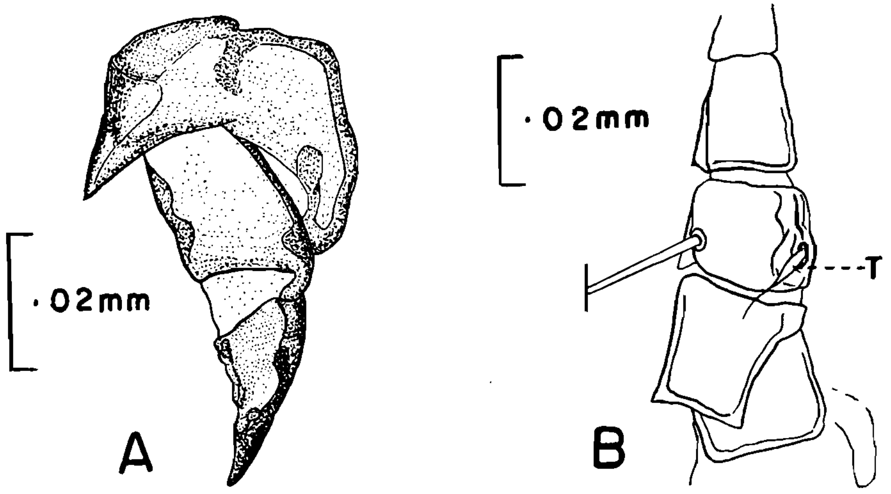

Fig. 4. *Audycoptes greeri* n. sp. ; A, left leg IV ventral view to show ventral spine of trochanter; B, left leg II dorsal view to show medially placed trichobothrium (T) on genu.

Audycoptes lawrencei n.s.p.

♀ A smaller species than *A. greeri.* Idiosoma a figure of eight in shape, somewhat recalling the larva of a simuliid fly in general appearance. Transverse striations more distinct than *A.greeri,* but as in the case of the latter species more pronounced on the propodosoma.

Dorsal surface.—Generally similar to that of *A.greeri* but differing in detail as regards the disposition and morphology of the sensory organs and setae. Propodosomal shield similar to that of *A.greeri,* flask-shaped and with fine punctations. Lateral propodosomal organs much larger than inner pair; lateral pair pad-like and quite unlike the thorn-shaped organs of *A.greeri* (see fig. 3, A), inner pair vesicle-like and generally very similar to those of *A.greeri.* Hysterosomal furcate setae resembling those of *A.greeri* but differing in that the thorn-like portion of the setae is relatively smaller, stouter, and not as attenuated (see fig. 3, B). Opisthosomal setae three in number as in *A.greeri,* but anterior pair much more laterally placed than in the larger species.

Ventral surface.—Similar to that of *A.greeri* except for arrangement of opithosomal setae. The pair of medial setae relatively longer than those of *A.greeri.* The anterior pair of lateral setae closer to the two posterior pairs which, although lying very close together, have distinctly separate setal bases. Anal and genital opening as in *A.greeri.*

Legs.—Anterior pair well separated from posterior pair and lying parallel to gnathosoma. Leg II lying over leg I. Legs III and IV do not protrude from sides of body as in *A.greeri;* when viewed from dorsal surface leg III partially hidden and leg

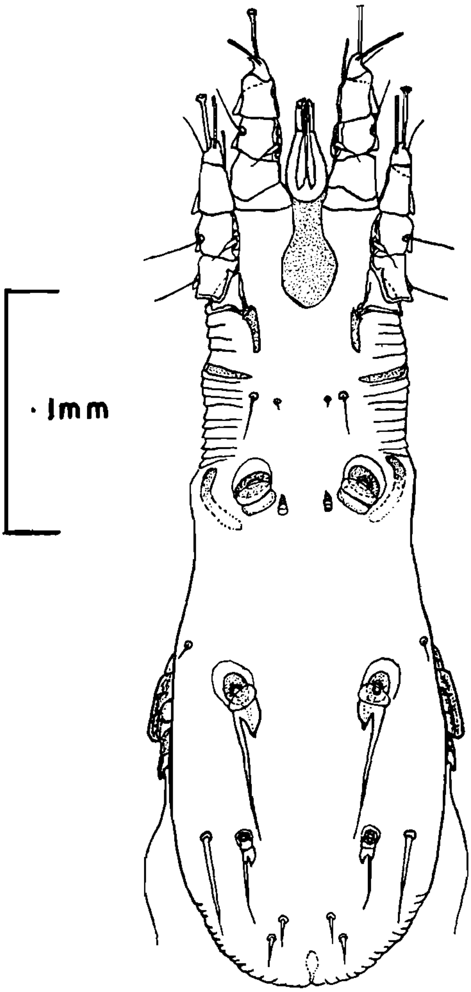

Fig. 5. *Audycoptes lawrencei* n. sp. ; dorsal view.

IV wholly hidden by hysterosoma. Epimera of legs I united to form a sternum, epimera of other legs free.

Legs I and II generally similar to those of *A.greeri* in general morphology and chaetotaxy. Trichobothrium of genu I and II resembling that of *A.greeri.* Legs III and IV generally resembling those of *A.greeri* in appearance but differing in certain important features. Trochanters greatly enlarged but lacking the powerful ventral spines. Tibia III and IV with a ventro-lateral thorn. Tarsi III and IV terminating in a powerful claw which is not, however, as stout as that of *A.greeri.* In addition to the claw, each tarsus bears a very long, thread-like seta, absent in *A.greeri.*

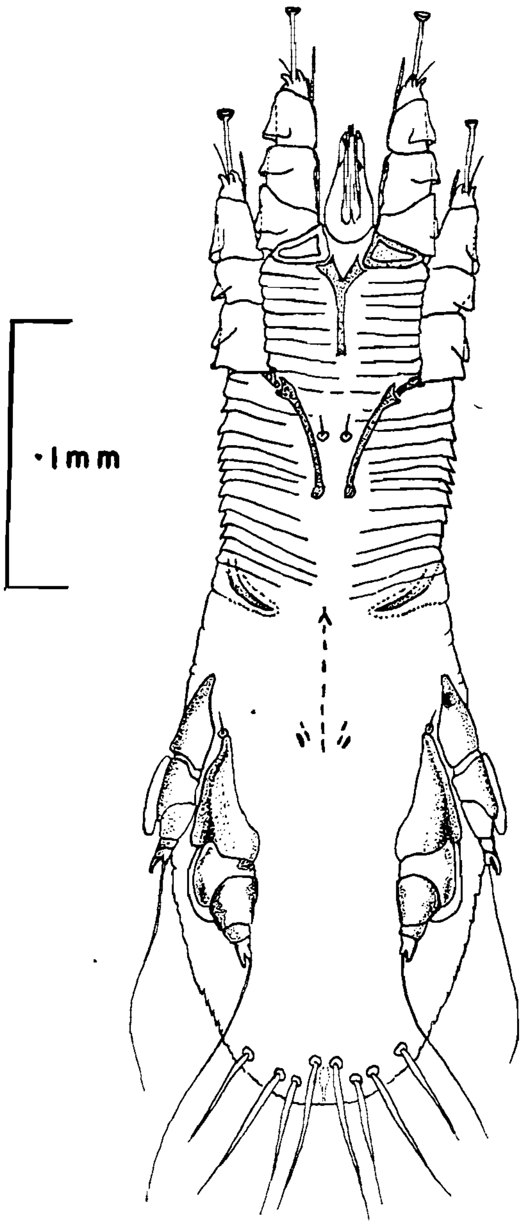

Fig. 6. *Audycoptes lawrencei* n. sp. ; ventral view.

Material examined.—A series of females, including several containing larvae, mounted after clearing in KOH in Ewing's modification of Berlese's gum chloral mountant. As in the case of *A.greeri* the anlage of the sensory organs and furcate setae are clearly visible. The measurements of five adult specimens are as follows:

Length (in mm) (From the tip of the gnathosoma to the end of the body)	Breadth (in mm) (Posteriorly, at widest portion)
0·347	0.110
0·338	0·110
0·338	0·118
0·338	0·118
0·365	0·118

Holotype and paratypes in the acarological collection of the Department of Entomology and Parasitology of the University of California at Davis and paratypes in the acarological collection of the George Williams Hooper Foundation, University of California Medical Centre, San Francisco.

Collected from several squirrel monkeys, *Saimiri sciurea*, shortly after their arrival in San Francisco from Eastern Peru. I have much pleasure in dedicating this species to Dr R. F. Lawrence.

SITE OCCUPIED BY THE MITES IN THE SKIN OF THE HOST

Both species of the remarkable mite described in this paper are parasites of the hair follicles of their hosts, living almost exclusively in specialized follicles (Stewart, 1933) known as sinus-hair follicles. It is apparently exceptional to find them in the normal follicles. Of several parasitized monkeys which were examined histologically, only one showed the parasites occurring both in the sinus-hair and normal follicles; the largest proportion of the mites, however, was observed in the sinus-hair follicles. This monkey was probably not typical of the wild population from which it originated since it had been kept in captivity in San Francicso for several months and harbored an unusually high number of audycoptids.

The sinus hairs are restricted to the supra-orbital margin, the upper and the lower lips and, unlike other hairs, possess deeply embedded follicles. These follicles are complex structures (fig. 7) composed of a very conspicuous outer connective tissue sheath enclosing a blood-filled cavernous sinus, which extends from the region of the sebaceous glands deep into the dermis below the germinal matrix of the hair root. The hair root floats, as it were, in a blood pool. The sebaceous glands open into the lumen of the follicle, above the cavernous sinus, by means of the pilo-sebaceous ducts. The function of the sinus hair in primates does not appear to be known, but they resemble the vibrissae of other mammals and presumably have a tactile function.

Audycoptes greeri and *A.lawrencei* have been found occupying only the upper part of the follicle, the mites lying between its opening onto the skin surface and the orifice of the pilo-sebaceous duct (see fig. 7). They have never been found deeper in the follicle than the level of the sebaceous glands. These mites differ sharply in habit from *Demodex* (an undescribed species has been discovered associated with the sinus hair of *Saimiri sciurea*) which does not limit its activities to the upper part of the follicle, but also penetrates deep down into the hair root.

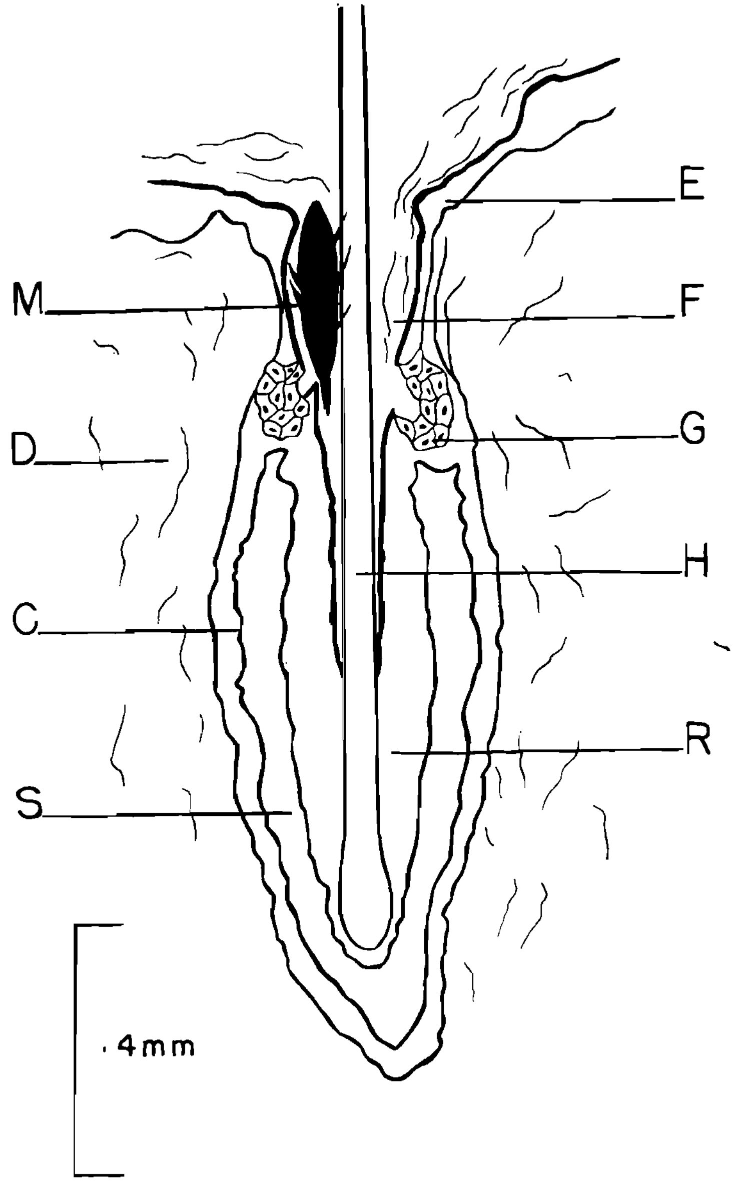

Fig. 7. Showing site occupied by *Audycoptes greeri* and *A. lawrencei* in a sinus-hair follicle of *Saimiri sciurea*. **C**, connective tissue sheath of follicle; **D**, dermis; **E**, epidermis; **F**, neck of follicle; **G**, sebaceous gland; **H**, hair; **M**, mite; **R**, hair root sheath; **S**, blood-filled cavernous sinus.

Audycoptids lie "head downwards", the tip of the gnathosoma either being directed into or resting in close proximity to the opening of the pilo-sebaceous canal. In this position the dorsal surface of the acarine is in contact with the hair, the propodosomal sensory organs and the hysterosomal furcate setae embracing the hair shaft; the ventral surface of the mite rests on the wall of the neck of the follicle. This habitude indicates that *Audycoptes* spp. probably feed directly on the product of the sebaceous gland which is a fatty material known as sebum and which is said to lubricate the surface of the skin. Interference with this natural process leads, in heavy infestations with audycoptids, to a breakdown in the defenses of the follicles and subsequent secondary infection with micro-organisms.

DISCUSSION

The living primates are regarded as being composed of about 18 families (Sanderson, 1957). It is estimated that approximately 750 species and varieties exist with an abundance of forms in both the New and the Old World. Of this number only a fraction have been examined for the presence of parasitic mites, the best explored groups being the lorisoids, lemuroids, cercopithecoids, and cynopithecoids, all the species and subspecies of which are restricted in their distribution to the Old World. While these groups of primates have yielded a rich harvest of acarines, nonetheless only a limited number of species have been exhaustively examined and it is certain that more extensive research will greatly extend the host list.

To assume from a study of the existing literature that Old World primates are more extensively parasitized than those of the New World would seem to be an unjustified conclusion in the present state of our knowledge. Old World forms have been examined in greater detail by the parasitologist (Mendheim, 1955; Ruch, 1959), particularly under field conditions, and some species, notably macaques, have long been available for study in large numbers in medical research centres. In fact our present understanding of the pathology of the pulmonary parasitoses caused by halarachnid mites is almost entirely derived from autopsies on macaques used in medical research on such problems as lung physiology, tuberculosis, poliomyelitis, and many other conditions. The few species of mites which have been collected from New World primates, for instance *Pneumonyssus stammeri* Vitzthum (1930) from the woolly monkey (*Lagothrix infumatus*), *Mortelmansia longus* Fain (1959), and *Mortelmansia brevis* Fain (1959) both from the squirrel monkey (*Saimiri sciurea*), have been discocovered as the result of haphazard circumstances far from the place of origin of the hosts. Little field work of any real acarological value has hitherto been undertaken on these animals. The survey which we have initiated on ectoparasites of New World primates has now quite clearly shown that these mammals are as rich a source of acarological material as their relatives from Asia and Africa, and it has brought to light many new forms of acarines, two of which are described in this paper under the names of *Audycoptes greeri* and *Audycoptes lawrencei*.

The affinities of the genus *Audycoptes* are not easy to determine, a difficulty increased by the failure to discover the male sex despite a meticulous search of a dozen parasitized squirrel monkeys. Insofar as the females are concerned, however, audycoptids appear to share certain features in common with acarines of the remarkable sarcoptiform family Rhynchoptidae, described by Lawrence in 1956 from an African porcupine, *Hystrix africaeaustralis*. Although it may appear to be stretching the point to establish affinities between the family Audycoptidae, occupying so specialized a habitat as the hair follicle of South American primates, and the family Rhynchoptidae, the only described species of which is known from an African hystricomorph rodent, nonetheless there are grounds for doing so. We have recently discovered an undescribed genus of rhynchoptids taken from a hapaloid primate, *Tamarinus nigricollis*, captured in Peru. Thus it is clear from this find that both rhynchoptids and audycoptids are found in the same zoogeographical region and that the two families share a common host group, whatever other hosts they may have. Moreover, it is our feeling, a belief which is discussed again later, that the ecological relationship of the families may be similar.

Since only the females of *Audycoptes* spp. are known, a comparison between acarines of the families Audycoptidae and Rhynchoptidae must be limited for the present to the female sex.

The general appearance of the mites is somewhat similar in that the idiosoma is elongated and both audycoptids and rhynchoptids possess only a single scutum, the dorsal propodosomal shield. Legs I and II in the two families show a superficial resemblance in that they have a calcarate appearance. In both families tarsi I and II end in a stalked pulvillus; although in the original description of *Rhynchoptes recurvidens* the mites were reported as being devoid of these structures, a careful reexamination of the paratypes has shown them to be present. In the rhynchoptids from the tamarin the stalked pulvilli of legs I and II are clearly visible, but the specimens were not cleared in KOH as in the case of *R.recurvidens* and were mounted directly in Ewing's gum chloral mountant. Of particular interest is the similarity of the trichobothrium of the genu of legs I and II of audycoptids to the scoop-like hair of the genu of the same two pairs of legs of rhynchoptids; the nature of the hair, however, appears to be fundamentally different in the two mites, that of the rhynchoptids not being trichobothrial in character.

The gnathosoma of the two families also shows some points of resemblance. In both it is conspicuously elongated, the chelicerae are chelate, and the short terminal segment of the palp bears processes. In the Rhynchoptidae the processes of the palp are numerous and clearly shaped as teeth, giving the palp the appearance of an acanthocephalan proboscis. In the Audycoptidae on the other hand the palpal processes are small, difficult to see, and not conspicuously tooth-like as in the rhynchoptids.

In other respects, however, the families Audycoptidae and Rhynchoptidae differ sharply from each other. Whereas the last two pairs of legs are greatly reduced in the Rhynchoptidae, in the Audycoptidae they are large, well sclerotized structures terminating in powerful claws. Nothing resembling the remarkable propodosomal sensory organs and furcate setae of the Audycoptidae are to be found in the Rhynchoptidae. despite these differences the two families certainly do appear to have affinities.

Lawrence's (1956) suggestion that rhynchoptids may be associated with the quills of porcupines and "perhaps feed near the bases of these" is interesting. The elongated idiosoma of these creatures and the striking similarity of their proterosoma to that of audycoptids leads one to suspect that rhynchoptids also might be parasites of the follicles. It would not be altogether surprising if future work showed this to be true.

It may be that the habit amongst the Acarina of parasitizing hair follicles is a much more widespread phenomenon than has hitherto been believed. It has, of course, long been known that the mammalian hair follicle is an excellent habitat for several species of mites, belonging in particular to the genera *Demodex* and *Psorergates*, but for many years nothing that is fundamentally new has been added to the concept of the follicle as a parasitological niche. The early work of Gruby (1845), Gmeiner (1908) and others on *Demodex* spp. and of Piana (1886) and Neumann (1893) on *Psorergates simplex* has been extended, but our present knowledge of follicular parasites and their habits is still largely limited to these two genera.

All species of mites which hitherto have been shown to be true parasites of the hair follicles belong to the suborder Trombidiformes. Although many sarcoptiform mites, as for example species of *Sarcoptes*, *Notoedres*, *Mysarcoptes*, *Psoroptes*, and *Chorioptes*, live in or on the skin of mammals, no unequivocal case of exploitation of the follicle as a habitat by a member of the suborder Sarcoptiformes had been demonstrated until the discovery of *Audycoptes*. It should be noted, however, that Lawrence's (1952) observations on *Alabidocarpus calcaratus* are highly suggestive. According to this author, the mite "evidently uses the flattened, shovel-like head to strip away the outer layers of the hair as it passes downward towards the follicle. The vibrissae of the nose-leaf of the host seem to be clotted with soft, fatty tissues near their roots and it may be that the mite is able to extract some nourishment from these substances and from the soft parts of the hair near its base." It would be most interesting if future histological work were to demonstrate that those species of listrophorids which possess an elongated idiosoma (such as *Alabidocarpus calcaratus*) are indeed parasites of the hair follicle. For, despite Baer's (1951, p.11) contention that convergence of morphological characteristics is not as a general rule a feature of the parasitic mode of life, such a demonstration would increase the examples of morphological convergence which appear to be presented by parasitic mites living in the hair follicles of mammals and in the feather shafts of birds. In these anatomical structures, both of which are tubular in form, the idiosoma of such quill inhabiting mites as the trombidiform, genera *Syringophilus*, *Picobia*, and *Cheletopsis* and the follicle inhabiting trombidiform genus *Demodex* and the sarcoptiform genus *Audycoptes* becomes greatly elongated. In fact the general appearance of *Audycoptes lawrencei*, with its long opisthosomal sensory setae, recalls very vividly that of several species of the quill-living genus *Syringophilus*.

Finally a point of unusual interest when considering *A.greeri* and *A.lawrencei* is that of the sharing of what appears to be the same niche* by two distinct species of mites of one genus. Strange as this behaviour may seem it is not unique, other instances of two species of a genus parasitizing the same species of host and apparently occupying the same niche being known among parasitic Acarina. Certainly the most interesting parallel situation is the occurrence of two closely related species of the sarcoptiform genus *Mortelmansia* in the nasal cavities of *Saimiri sciurea* (Fain, 1959), the identical species of host as that parasitized by the two audycoptids. The squirrel monkey is by no means unique in this respect since other examples of related mites occupying the same niche are to be found for example amongst the intranasal trombiculiids of certain forest rats of Malaysia and Africa (Audy and Nadchatram, 1957). *Saimiri sciurea,* however, lives well in captivity and is gentle to handle and should prove to be a most suitable animal host for studies on phenomena such as competitive balance and ecological oscillations (Ross, 1962) between two species of parasites.

REFERENCES

AUDY, J. R. 1958. The localisation of disease with special reference to the zoonoses. *Trans.R.Soc. trop.Med.Hyg.* **52:** 308-328.

——— and Nadchatram, M., 1957. Malaysian parasites, XXVI. New intranasal species of *Traubacarus* n.gen. (Acarina, Trombiculidae). *Stud.Inst.med.Res., Malaya,* **28,** 187-230.

BAER, J. G. 1951. The ecology of animal parasites. Urbana: University of Illinois Press.

FAIN, A. 1957. Notes sur l'acariose des voies respiratoires chez l'homme et les animaux. Description de deux nouveaux acariens chez un lémurien et des rongeurs. *Ann.Soc.belge Méd.trop.* **37:** 469-482.

——— 1959a. Deux nouveaux acariens nasicoles chez un singe platyrrhinien *Saimiri sciurea* (L.) (Lemurnyssidae: Sarcoptiformes). *Bull.Soc.zool.Anvers,* No. 12, 3-12.

——— 1959b. Deux nouveaux genres d'acariens vivant dans l'épaisseur des muqueuses nasales et buccale chez un Lémurien (Trombidiformes: Demodicidae). *Bull.(Ann.) Soc.ent.Belg.* **9-10:** 263-273.

DA FONSECA, F., 1954. Sistemática e filogênese de Psoralgidae Oudemans, sarcoptiformes parafagistas de mámiferos com morfologia de Acari plumicolas. *Mem.Inst.Butantan* **26:** 93-167.

GAUD, J. and TILL, W. 1957. Analgesoidea ectoparasites de singes et de lemuriens. *Ann.Parasit. hum.comp.* **31:** 136-144.

GMEINER, F. 1908. *Demodex folliculorum* des Menschen und der Tiere. *Arch.Dermat.Syph.Wien* **92:** 25-96.

GRAHAM, G. L. 1960. Parasitism in monkeys, in 'Care and diseases of the research monkey'. Sauer, R. M., Ed. *Ann.N.Y.Acad.Sci.* **85:** 842-860.

GRUBY, D. 1845. Recherches sur les animalcules parasites des follicules sébacés et des follicules des poils de la peau de l'homme et du chien. *C.R.Acad.Sci., Paris* **20:** 569-572.

LAVOIPIERRE, M. M. J., 1955. A description of a new genus of sarcoptiform mites and of three new species of Acarina parasitic on primates in the British Cameroons. *Ann.trop. Med.parasit.* **49:** 299-307.

——— and CREWE, W., 1955. The occurrence of a mange mite, *Psorergates* sp. (Acarina), in a West African monkey. *Ann.trop.Med.Parasit.* **49:** 351.

LAWRENCE, R. F. 1952. Two new mite parasites of Natal bats (Listrophoridae, Sarcoptiformes). *Parasitology* **42:** 136-143.

——— 1956. Studies on South African fur mites (Trombidiformes and Sarcoptiformes). *Ann.Natal Mus.* **13:** 337-375.

——— 1958. Studies on the listrophorid fur mites of Madagascar lemurs. *Mém.Inst.sci. Madagascar,* Ser. A, **12:** 113-125.

---

* The term "niche" is here used in the sense that it was defined by Audy (1958).

MENDHEIM, H. 1958. Tierische Parasiten und parasitäre Krankheiten in 'Pathologie der Laboratoriumstiere.' 2: 149-237, Cohors, P., Jaffe, R., and Meessen, H., eds. Berlin-Gottingen-Heidelberg: Springer Verlag.

NEUMANN, M. G. 1893. Sur un acarien (*Psorergates simplex* Tyrrell) de la souris. *Bull.Soc.Hist.nat., Toulouse* **27**: 13-22.

PIANA, G. P. 1886. Cisti cutanee contenenti acari nei topi. *Annuario per l'anno scolastico* 1885-86 (*R. Scuola sup. di med. veterinaria di Milano*), p. 122. (Cited by Neumann, 1893).

ROSS, H. H. 1962. A synthesis of evolutionary theory. New Jersey: Prentice-Hall.

RUCH, T. C. 1959. Diseases of laboratory primates. Philadelphia: W. B. Saunders.

SANDERSON, I. 1957. The monkey kingdom. An introduction to the study of primates. New York: Hanover House.

STEWART, T. D. 1933. The skin and its appendages in 'The anatomy of the rhesus monkey (*Macaca mulatta*)'. pp. 28-35, Hartman, C. G. and Straus, W. L., Eds. New York: Hafner Publishing Co.

VITZTHUM, H. 1930. *Pneumonyssus stammeri*, ein neuer Lungenparasit. *Z. Parasitenk.* **2**: 595-615.

ZUMPT, F. and TILL, W. 1955. The mange-causing mites of the genus *Psorergates* (Acarina: Myobiidae) with description of a new species from a South African monkey. *Parasitology* **45**: 269-274.

Date received: 13th February, 1963